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SPECIFICATION FOR MECHANICAL COUPLER FOR MEASUREMENT ON BONE VIBRATORS

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NEW DELHI 110002

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***September* 1986**

Indian Standard

SPECIFICATION FOR MECHANICAL COUPLER FOR MEASUREMENT ON BONE VIBRATORS

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Indian Standard

SPECIFICATION FOR MECHANICAL COUPLER FOR MEASUREMENT ON BONE VIBRATORS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 25 September 1985, after the draft finalized by the Acoustics Sectional Committee had been approved by the Electronics and Telecommucication Division Council.

0.2 The purpose of this standard, as applied to audiometry, is to provide a means of calibrating bone vibrators of the types used in bone-conduction audiometry by specifying a standardized mechanical impedance with which to load the vibrator and a device for measuring the alternating force produced. Reference equivalent threshold force levels corresponding to the normal threshold of hearing are specified in IS : 11024-1984*. For this application, the bone vibrator is required to have plane circular tip area of 175 ± 25 mm^2 and to be applied to the mechanical coupler with a static force of 5·4 ± 0·5 N, as specified in IS : 10565-1983†. The mechanical coupler is also intended for other measurements on bone vibrators for audiometers namely, frequency response, unwanted sound radiation, harmonic, distortion, etc.

0.3 The purpose of this standard, as applied to hearing aids, is to provide a means of measuring the electro-mechanical characteristics (sensitivity, frequency response, harmonic distortion, etc) of bone vibrators used in hearing aids, or the acousto-mechanical characteristics of complete hearing aids of the bone conduction type, when dynamically loaded by a specified mechanical impedance and applied with a static force in the range 1·7 to 4 N.

0.4 While preparing this standard assistance has been derived from IEC 29C (CO) 50 Draft Mechanical coupler for measurements on bone vibrators.

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*Standard reference zero for the calibration of pure-tone bone conduction audiometers and guidelines for its practical application.

†Diagnostic audiometer.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies requirements for mechanical couplers used for calibrating bone-conduction audiometers and for making measurements on bone vibrators and bone-conduction hearing aids, in the frequency range from 125 to 8 000 Hz inclusive.

2. TERMINOLOGY

2.0 For the purpose of this standard, the terms and definitions given in IS : 1885 (Part 3/Sec 5)-1966† shall apply in addition to the following.

2.1 Bone Vibrator — An electro-mechanical transducer intended to produce the sensation of hearing by vibrating the cranial bones.

2.2 Mechanical Coupler — A device designed to present a specified mechanical impedance to a vibrator applied with a specified static force, and equipped with a mechano-electric transducer to determine the alternating force level at the surface of contact between vibrator and mechanical coupler.

2.3 Alternating Force Level (Force Level) — twenty times the logarithm to the base 10 of the ratio of the rms value of the force transmitting the vibration to the reference value of 1 micronewton (1 μN). Unit : dB.

2.4 Mechanical Impedance — of a sinusoidally vibrating object at a specified frequency. The complex quotient of the alternating force transmitting the vibration to the component of velocity of the object in the direction of the force. Unit : Nsm^{-1}.

2.5 Mechanical Impedance Level — twenty times the logarithm to the base 10 of the ratio of the absolute value (modulus) of the mechanical impedance to the reference value of 1 Nsm^{-1}. Unit : dB.

---

*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary: Part 3 Acoustics, Section 5 Speech and hearing.

2.6 Mechanical Resistance — The real part of the (complex) mechanical impedance.

2.7 Mechanical Reactance — The imaginary part of the (complex) mechanical impedance.

NOTE — By convention, mechanical reactance due to inertia is assigned a positive sign.

2.8 Sensitivity Level — Twenty times the logarithm to the base 10 of the ratio of the sensitivity of a mechanical coupler, defined as electrical output in volts for an applied alternating force in newtons, to the reference sensitivity of 1V/N. Unit : dB.

3. REQUIREMENTS

3.1 General — The mechanical coupler shall consist, in essence, of a rigid mass of approximately 3·5 kg containing a force-sensing element and surmounted by visco-elastic material having an external profile as specified in **3.4**. The mechanical impedance of the assembly for uniaxial vibration which is coincident with its major axis of symmetry shall comply with the specifications in **3.2** and **3.3**. The whole assembly shall be supported in such a way as to be capable of sustaining a static force of up to 6 N (including the weight of the vibrator under test, if mounted on a vertical axis) with a frequency of natural oscillation on the supports not greater than 12·5 Hz.

NOTE 1 — It is recommended to include a temperature-sensing device in intimate contact with the bulk mass of the mechanical coupler, to permit correct measurement of its temperature during use and calibration (*see* **4.3**).

NOTE 2 — An example of a mechanical coupler complying with this standard is described in Appendix A.

3.2 Mechanical Impedance Level — The mechanical coupler shall present a mechanical impedance at a temperature of 23·0°C having the levels specified in Table 1 together with tolerances, when driven by a vibrator having a plane circular tip of area 175 mm^2 and applied with a static force of 5·4 N including (where the apparatus is mounted with its axis vertical) the weight of the vibrator and of any unsupported components of the force-delivery device.

NOTE 1 — Values of the mechanical impedance level and tolerances are derived from experimental data on examples of mechanical coupler.

Under similar conditions but with the static force reduced to 2·5 N the mechanical impedance level at 250 Hz shall be 2·0 ± 0·5 dB below the value measured with the static force of 5·4 N.

TABLE 1 MECHANICAL IMPEDANCE LEVEL

(*Clauses* 3.2, 4.1 *and* 4.2)

Frequency	Mechanical Impedance Level (Reference : 1 Nsm^{-1})	Tolerance
Hz	dB	dB
125	48·9	±2·0
160	47·4	,,
200	45·8	,,
250	44·3	,,
315	42·9	,,
400	41·3	,,
500	39·9	,,
630	38·5	,,
750*	37·4	,,
800	37·0	,,
1 000	35·5	,,
1 250	34·0	±2·5
1 500*	32·4	,,
1 600	31·9	,,
2 000	29·8	,,
2 500	27·8	,,
3 000*	27·2	,,
3 150	27·3	,,
4 000	29·5	,,
5 000	32·6	,,
6 000*	34·4	,,
6 300	34·6	,,
8 000	35·1	,,

*These frequencies are used in audiometry but are not included in the preferred series specified in IS : 2264 - 1963†.

†Preferred frequencies for acoustical measurements.

Note 2 — This constitutes a performance specification and the lower value of static force is not necessarily that recommended to be used when testing any particular device.

3.3 Phase Angle of Mechanical Impedance — The phase angle of the mechanical coupler at a frequency of 250 Hz and a temperature of 23°C shall be −63° ± 4°, when driven under the same conditions as specified in **3.2**, with a static force of 5·4 N.

3.4 External Geometry — The contact surface of the mechanical coupler, in the undeformed state, shall be spherical with a nominal radius of

96 mm. The exposed portion of the sphere shall be circular in shape with a minimum diameter of 35 mm. Within this diameter the surface shall be smooth and the tolerance on the spherical radius shall be ± 15 mm. Outside this diameter the external profile of the mechanical coupler shall be such as to avoid interference with any bone vibrator which it is intended to test.

3.5 Attachment of Vibrator — Means shall be provided for applying the vibrator under test to the mechanical coupler with the requisite static force. This device shall permit the calibration of vibrators mounted on a headband or of isolated vibrators without causing spurious response of the vibrator.

NOTE 1 — It is recommended that the force-producing mechanism (for example, springs or gravity-loading mechanism) provided on the mechanical coupler be decoupled from the vibrator under test by means of elastic bands applied symmetrically to the back of the vibrator, the elastic bands having negligible stiffness in the direction of the vibration.

NOTE 2 — For measurements on headband-mounted vibrators it is recommended that provision be made to spread the headband so as to develop the required static force. The free end of the headband should bear on a resilient material to reduce spurious resonance effects and the headband should not shunt the springs used to resiliently mount the mechanical coupler.

NOTE 3 — Means should be provided for locating the vibrator symmetrically on the mechanical coupler.

An example of one form of mounting is shown in Fig. 2 of IS : 10776 (Part 4)-1984*.

4. CALIBRATION

4.1 Sensitivity Level — The mechanical coupler shall be calibrated by the manufacturer at 23° ± 1°C in terms of its sensitivity level at the frequencies listed in Table 1.

The alternating force shall be applied via a plane-ended circular driving plate of area 175 mm^2, and values of sensitivity level shall be given for coupling forces of 5·4 and 2·5 N. The electrical load conditions shall be stated. A calibration table or a graph shall be supplied with each mechanical coupler, together with a statement defining the uncertainty. The calibration uncertainty shall not exceed 1·0 dB for frequencies up to and including 2 kHz nor shall it exceed 2·0 dB for frequencies up to and including 8 kHz.

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*Methods of measurement of electroacoustic characteristics of hearing aids: Part 4 Hearing aids with bone vibrators.

NOTE 1 — Measurement of the applied alternating force usually requires compensation for the mass of material in the driving stylus between the calibrated force transducer and the external surface, and the instructions of the transducer manufacturer should be followed.

NOTE 2 — For the purpose of calibration and elsewhere in this standard where temperature is specified, it is to be understood that the temperature is that of the mechanical coupler. Due to the large thermal capacity of the mass comprising the bulk of the device it may take several hours to attain thermal equilibrium. It is not reliable to depend on a measurement of room temperature.

4.2 Mechanical Impedance Level — A table or a graph shall be supplied by the manufacturer with each mechanical coupler giving the results of measurements of the mechanical impedance level at 25° ± 1°C at the frequencies listed in Table 1, under conditions specified in **3.2**.

4.3 Temperature Dependence — As a type requirement; measurements as in **4.1** and **4.2** shall be carried out additionally over a temperature range of at least 18° to 28°C, at a sufficient number of frequencies to characterize the temperature dependence of sensitivity level and mechanical impedance level. This information shall be supplied in the form of temperature coefficients valid over a stated temperature range.

NOTE — These data are required purely as indicators of temperature dependence. In general, the values for the temperature dependence cannot be used directly to correct data measured at other temperatures to the reference temperature of 25°C, as the effect of the change in mechanical impedance level on the alternating force output of the bone vibrator under test will not be known.

5. MARKING AND INSTRUCTION MANUAL

5.1 Marking of the Mechanical Coupler — Mechanical couplers complying with this standard shall be marked with the manufacturer's name or trade-mark, a serial number, and reference to this standard by number.

5.1.1 The mechanical couplers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

5.2 Instruction Manual — The mechanical coupler shall be provided with an instruction manual which, as a minimum, shall contain the information required by 4. Notwithstanding it shall also contain the following:

a) Detailed instructions which need to be followed to ensure that in use the coupler meets the requirements of this standard.

b) Details of the recommended calibration procedures.

c) The limits of temperature and humidity beyond which permanent damage to the mechanical coupler may result.

APPENDIX A

(*Clause* 3.1)

EXAMPLE OF A SPECIFIC CONSTRUCTION OF A MECHANICAL COUPLER

A-1. MECHANICAL IMPEDANCE ELEMENT

A-1.1 Visco-Elastic Components

i) *Butyl Pad*

The butyl pad (Fig. 1) is in the form of a flat plate of diameter approximately 40-50 mm and thickness 3·8 mm. The composition for the butyl is as follows:

Butyl 35 SH	*Parts by Weight*
Butyl	100
Medium thermal carbon black	50
Zinc oxide (lead free)	5
Sulphur	2
Magnesia	1
Octamine	1
Tetra methyl thiorem disulphide	1·5
Mercopto benz thiozyl disulphide	1

Mixture must be processed within 60 days.

ii) *Neoprene Rubber Pad*

The neoprene rubber pad is in the form of a flat plate of diameter approximately 40-50 mm and thickness 3·1 mm. The composition for the neoprene rubber is as follows:

Neoprene 35 SH	*Parts by Weight*
Neoprene S-40	125
Sevalblack	50
Magnozink	5
Sterric acid	2·5
Octamine	2·5
Ethylene thio urea	1·6
Faktis	12·5
Dutrex	25
Butyl oleat	25
Polyethylene	3·8

Mixture must be processed within 60 days.

A-1.2 Metal Components

i) Base of mechanical impedance element

The base consists of stainless steel prepared for vulcanization by a proper primer (Fig. 1). The upper surface has a spherical radius of 89 ± 0·5 mm and should be free from obvious turning marks or other blemishes.

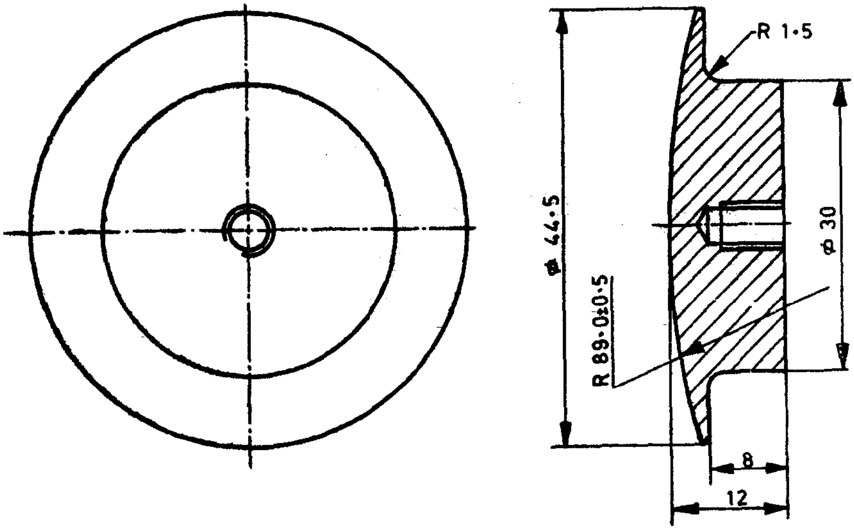
ii) Loading insert

The loading insert is in the form of a frustrum of a cone of thickness 2·5 ± 0·05 mm, as shown in Fig. 2. The insert should be accurately turned from tungsten alloy density 17 Mgm^{-3}.

A-1.3 Assembly — The neoprene rubber is vulcanized to the steel base under a pressure of 0·25 MPa at a temperature of 170°C for 20 min. The vulcanized steel base with neoprene and the tungsten mass (Fig. 2) are primed and the butyl disc is vulcanized under a pressure of 0·13 MPa at a temperature of 155°C for 20 min. The vulcanized mechanical impedance element shall meet the required tolerances (*see* **3.2** to **3.4**).

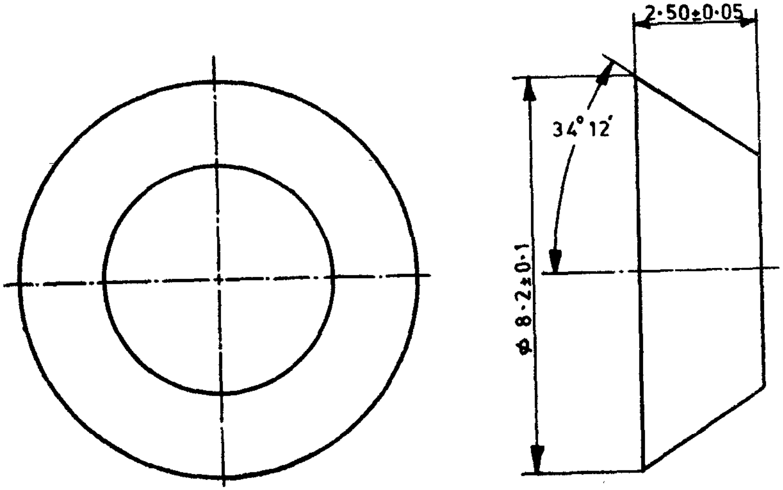
A-2. GENERAL ASSEMBLY

A-2.1 The mechanical impedance element is mounted on the brass body as shown in Fig. 3, a piezoelectric force sensing element being clamped between them.



All dimensions in millimetres.

FIG. 1 DIMENSIONS OF MECHANICAL IMPEDANCE ELEMENT BASE



All dimensions in millimetres.

FIG. 2 DIMENSIONS OF TUNGSTEN LOADING INSERT

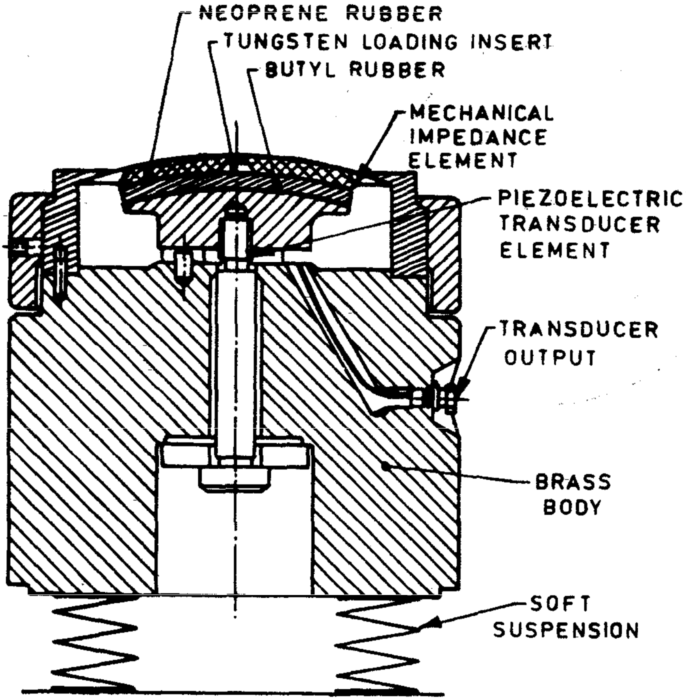


FIG. 3 ASSEMBLY OF THE MECHANICAL COUPLER